WO 01/09695
PCT/GB00/02931

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTICE INFORMING THE APPLICANT OF THE COMMUNICATION OF THE INTERNATIONAL APPLICATION TO THE DESIGNATED OFFICES

(PCT Rule 47.1(c), first sentence)

To:
THAKER, Shalini
Group IPR Department
Huntleigh Technology PLC
310-312 Dallow Road
Luton
Bedfordshire LU1 1TD
ROYAUME-UNI

RECEIVED

Date of mailing (day/month/year): 08 February 2001 (08.02.01)	
Applicant's or agent's file reference: P3075	IMPORTANT NOTICE
International application No.: PCT/GB00/02931	International filing date (day/month/year): 28 July 2000 (28.07.00)
Priority date (day/month/year): 31 July 1999 (31.07.99)	
Applicant: HUNTLEIGH TECHNOLOGY PLC et al	

1. Notice is hereby given that the International Bureau has communicated, as provided in Article 20, the international application to the following designated Offices on the date indicated above as the date of mailing of this Notice:
   AU,KP,KR,US

   In accordance with Rule 47.1(c), third sentence, those Offices will accept the present Notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

2. The following designated Offices have waived the requirement for such a communication at this time:
   AE,AG,AL,AM,AP,AT,AZ,BA,BB,BG,BR,BY,BZ,CA,CH,CN,CR,CU,CZ,DE,DK,DM,DZ,EA,EE,EP,ES,
   FI,GB,GD,GE,GH,GM,HR,HU,ID,IL,IN,IS,JP,KE,KG,KZ,LC,LK,LR,LS,LT,LU,LV,MA,MD,MG,MK,
   MN,MW,MX,MZ,NO,NZ,OA,PL,PT,RO,RU,SD,SG,SI,SK,SL,TJ,TM,TR,TT,TZ,UA,UG,UZ,VN,YU,ZA,
   The communication will be made to those Offices only upon their request. Furthermore, those Offices do not require the applicant to furnish a copy of the international application (Rule 49.1(a-bis)).

3. Enclosed with this Notice is a copy of the international application as published by the International Bureau on
   08 February 2001 (08.02.01) under No. WO 01/09695

REMINDER REGARDING CHAPTER II (Article 31(2)(a) and Rule 54.2)

If the applicant wishes to postpone entry into the national phase until 30 months (or later in some Offices) from the priority date, a demand for international preliminary examination must be filed with the competent International Preliminary Examining Authority before the expiration of 19 months from the priority date.

It is the applicant's sole responsibility to monitor the 19-month time limit.

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

REMINDER REGARDING ENTRY INTO THE NATIONAL PHASE (Article 22 or 39(1))

If the applicant wishes to proceed with the international application in the national phase, he must, within 20 months or 30 months, or later in some Offices, perform the acts referred to therein before each designated or elected Office.

For further important information on the time limits and acts to be performed for entering the national phase, see the Annex to Form PCT/IB/301 (Notification of Receipt of Record Copy) and Volume II of the PCT Applicant's Guide.

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No. (41-22) 740.14.35

Authorized officer
J. Zahra

Telephone No. (41-22) 338.83.38

TENT COOPERATION TRE/ Y

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92bis.1 and Administrative Instructions, Section 422)

To:

THAKER, Shalini
Group IPR Department
Huntleigh Technology PLC
310-312 Dallow Road
Luton
Bedfordshire LU1 1TD
ROYAUME-UNI

Date of mailing (day/month/year)
25 January 2001 (25.01.01)

Applicant's or agent's file reference
P3075

IMPORTANT NOTIFICATION

International application No.
PCT/GB00/02931

International filing date (day/month/year)
28 July 2000 (28.07.00)

1. The following indications appeared on record concerning:

[X] the applicant [X] the inventor [ ] the agent [ ] the common representative

Name and Address
NEWTON, Michael, David
8 Tyn Y Waun Road
Machen
Gwent
South Wales NP1 8LA
United Kingdom

State of Nationality: **
State of Residence: GB
Telephone No.:
Facsimile No.:
Teleprinter No.:

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

[ ] the person [ ] the name [ ] the address [X] the nationality [ ] the residence

Name and Address
NEWTON, Michael, David
8 Tyn Y Waun Road
Machen
Gwent
South Wales NP1 8LA
United Kingdom

State of Nationality: GB
State of Residence: GB
Telephone No.:
Facsimile No.:
Teleprinter No.:

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

[X] the receiving Office
[ ] the International Searching Authority
[ ] the International Preliminary Examining Authority
[X] the designated Offices concerned
[ ] the elected Offices concerned
[ ] other:

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer
I. Britel

Telephone No.: (41-22) 338.83.38

PATENT COOPERATION TREAT

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION**	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
P3075		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/GB 00/ 02931	28/07/2000	31/07/1999

Applicant

HUNTLEIGH TECHNOLOGY PLC

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

a. With regard to the **language,** the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

[ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

[ ] contained in the international application in written form.

[ ] filed together with the international application in computer readable form.

[ ] furnished subsequently to this Authority in written form.

[ ] furnished subsequently to this Authority in computer readble form.

[ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

[ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title,**

[X] the text is approved as submitted by the applicant.

[ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**

[X] the text is approved as submitted by the applicant.

[ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 1

[ ] as suggested by the applicant.

[ ] because the applicant failed to suggest a figure.

[X] because this figure better characterizes the invention.

[ ] None of the figures.

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 00/02931

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G05D7/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G05D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	US 5 671 730 A (OLLILA RAUNO) 30 September 1997 (1997-09-30) the whole document --- US 4 806 833 A (YOUNG GLEN C) 21 February 1989 (1989-02-21) column 4, paragraph 5 column 6, paragraph 3 -column 9, paragraph 3 figure 5 --- US 4 905 687 A (PONKALA JORMA) 6 March 1990 (1990-03-06) the whole document --- -/--	1-3,5,8, 14 4 6,7,9-13 1-3,9, 11,12,14 13 4-8,10 1,2,5, 8-10,12, 14 3,4,6,7, 11,13

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 October 2000	10/11/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Philippot, B

2

Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5 599 174 A (COOK STEPHEN J ET AL) 4 February 1997 (1997-02-04)	4
A	figure 1	1-3

Y	US 5 736 823 A (NORDBY CRAIG J ET AL) 7 April 1998 (1998-04-07)	13
A	figure 1	9

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB 00/02931

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5671730 A	30-09-1997	FI 940894 A	26-08-1995
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		GB 2295424 A,B	29-05-1996
		JP 9502496 T	11-03-1997
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9917961.6 31 July 1999 (31.07.1999) GB

(71) Applicant *(for all designated States except US)*: **HUNTLEIGH TECHNOLOGY PLC** [GB/GB]; 310-312 Dallow Road, Luton, Bedfordshire LU1 1TD (GB).

(72) Inventors; and

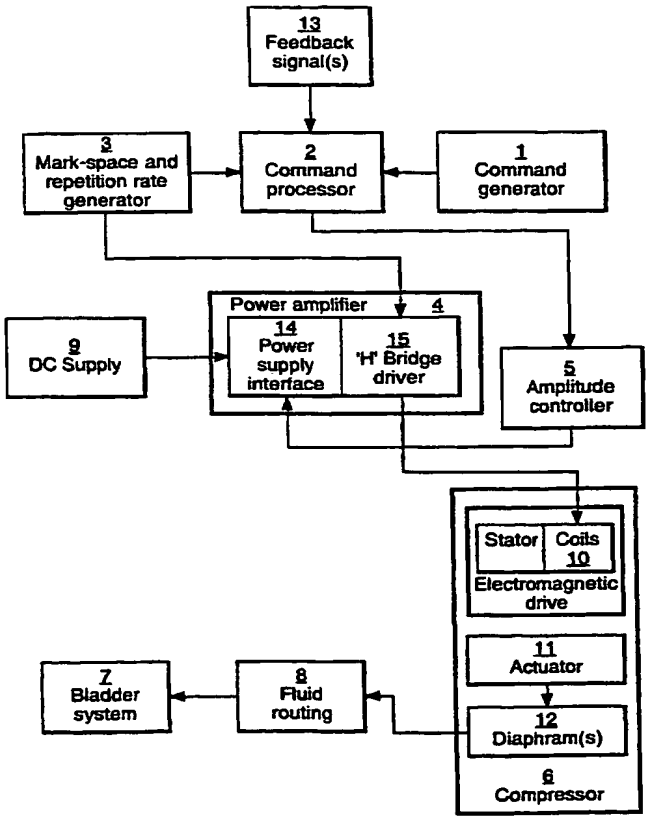
(75) Inventors/Applicants *(for US only)*: **BEALE, Alan** [GB/GB]; 510 Chepstow Road, Newport, South Wales NP19 9DB (GB). **COOK, Stephen, John** [GB/GB]; 6 Greystoke Road, Caversham, Reading RG4 5EL (GB). **NEWTON, Michael, David** [—/GB]; 8 Tyn Y Waun Road, Machen, Gwent, South Wales NP1 8LA (GB).

(74) Agent: **THAKER, Shalini**; Group IPR Department, Huntleigh Technology PLC, 310-312 Dallow Road, Luton, Bedfordshire LU1 1TD (GB).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

[Continued on next page]

(54) Title: COMPRESSOR DRIVE



(57) Abstract: A fluid flow control system for an electromagnetic pump having an electromagnetic drive (11) and a compressor (6). The control system establishes a required current in the compressor coils (10) to control the position and movement of the actuator (11), the actuator deflecting a diaphragm within the pump to provide the required flow. The control system includes a command signal generator (1) to create a signal representing the required flow, the signal is applied to a command processor (2) with any feedback signal(s) (13) for example, coil current, actuator displacement. The command processor (2) calculates the appropriate drive signal defined by mark-space ratio, repetition rate and amplitude. The drive signal controls the voltage supplied to the compressor coils (11) resulting in a required coil current to provide the desired flow. A dc power supply is used to avoid problems regarding mains power supply and frequency.

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(84) **Designated States** *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *With international search report.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

COMPRESSOR DRIVE

The present invention relates to a fluid flow control system and particularly a fluid flow control system for an electromagnetic pump which can provide any desired variable fluid flow rate.

Conventionally electromagnetic pumps operate from mains power and the compressors within the electromagnetic pumps operate directly from this single phase mains power which provides the compressor electrical drive input voltage and frequency. Therefore these compressors operate at constant fluid flow, and any fluid flow control depends merely on on/off control or on fluid loading conditions. The necessary fluid flow rates are obtained by the control and design of the fluid routing system.

Such compressors include linear or arcuate motion reciprocating actuators driven by electromagnetic drive means supplied by the mains power voltage and frequency. The electromagnetic drive means drive the actuators into reciprocating mechanical motion which is translated by diaphragms and valves into fluid flow from one or more compressor inputs to one or more compressor outputs.

This approach has a number of problems including the design of the compressor having to vary with the value of mains power voltage and frequency, complicating manufacture and driving up costs. Furthermore, flow control only by air routing compromises the compressors' life, the compressors having to be operated continually at maximum capacity with the consequence of maximum noise and vibration during use.

Furthermore, the performance of the compressors is largely dependent on the mechanical characteristics of its components, for example the diaphragm stiffness, the moving mass, and also the stiffness of the compressed air within the pump.

Any variation either between units of manufacture or within environmental operating conditions or through use will cause additional performance variation.

The aim of the present invention is to provide a fluid flow control system for an electromagnetic pump that is not dependent on the voltage and frequency of the mains power supply and provides the desired fluid flow with the optimum performance of the pump.

Accordingly, the present invention provides a fluid flow control system for an electromagnetic pump comprising electromagnetic drive means within a compressor, the control system supplying a pulse width modulated drive signal to the electromagnetic drive means so as to supply a predetermined pump flow rate, the drive signal generated from a dc voltage supply.

Preferably, the pulse width modulated drive signal comprises a train of variable mark space ratio pulses with defined repetition rates and amplitude. By varying the mark space ratio with time and appropriately defining its repetition rate and amplitude a drive signal compatible with the required flow rate can be obtained.

Preferably, the electromagnetic drive means includes stator(s) of magnetic material, excitation winding(s) for magnetically exciting the stator(s) and a movable magnetic member connected to the actuator of the compressor. An actuator deflection results in a corresponding deflection

of the attached diaphragm(s) and in flow of any fluid in contact with the diaphragm(s).

Preferably, the electromagnetic drive means in combination with diaphragms provides a conversion of electrical energy to fluid flow.

Preferably, the pulse width modulated drive signal controls the instantaneous current within the excitation windings. This current by controlling actuator deflection amplitude and repetition rate controls fluid flow within the compressor.

Preferably the mark-space ratio of the drive signal defines with time an approximate half sinewave waveform.

Preferably, the pulse width modulated drive signal is of substantially constant amplitude. Pulse width modulated control from a dc power supply ensures the compressor is always operating with optimum efficiency for any application, the compressor performance being independent of mains power type or variations and allowing the possibility of using batteries to operate the pumps. Therefore, the problems associated with existing fixed frequency mains voltage driven compressors and pumps are avoided.

According to a further aspect of the present invention, there is provided a fluid flow control system for an electromagnetic pump comprising electromagnetic drive means within a compressor, the control system supplying a pulse width modulated low voltage drive signal of substantially fixed amplitude to the electromagnetic drive means to control the amplitude and repetition rate of the current in the coils of the electromagnetic drive

means to drive the actuator in order to generate a desired flow rate output from the compressor.

Preferred embodiments of the present invention will now be described in detail by way of example only, with reference to the accompanying drawings of which:

Figure 1 shows a block diagram of the fluid flow control system according to the present invention;

Figure 2a shows the bipolar voltage drive signal;

Figure 2b shows the unipolar drive signal from the mark space/repetition rate generator;

Figure 2c shows actuator current;

Figure 3 shows a block diagram of one embodiment of a control system of Figure 1 supplying fluid to a bladder; and

Figure 4 shows a block diagram of another embodiment of a control system of Figure 1 supplying fluid to a bladder;

Figure 5 shows a block diagram of a further embodiment of a control system of Figure 1 supplying fluid to a bladder; and

Figure 6 shows a block diagram of a further embodiment of a control system of Figure 1 supplying fluid to a bladder.

Referring to the block diagram at Figure 1 there is shown a controlled fluid flow system comprising a control system, fluid routing, a bladder system (7) and a compressor comprising one or more diaphragms (12) attached to an electromagnetic actuator (11).

The control system establishes a required current in the compressor (6) coil or coils (10) at any instant in time. The coil current controls the position of the

actuator (11) which deflects the diaphragm(s) (12) appropriately thereby providing flow of any fluid in contact with the diaphragm(s)(12). Controlling the current in the coil(s)(10) controls the fluid flow from the compressor (6).

A command signal representing the required fluid flow is created in the command generator (1) and applied to the command processor (2) in conjunction with any feedback signal(s)(13) derived from the coil current sensor, actuator position sensor, bladder flow sensor and bladder pressure sensor. They provide signals representing instantaneous coil current, actuator displacement flow into or out of the bladder system (7) and bladder system (7) pressure.

The output of the command generator (1) and the feedback signals (13) are processed in the command processor (2) using a control algorithm which is representative of the pneumatic, mechanical and electrical characteristics of the compressor that is to be driven. From the control algorithm an appropriate drive signal is calculated, defined by mark-space ratio, repetition rate and amplitude parameters.

Drive signal amplitude is obtained via the amplitude controller (5) appropriately changing the power supply interface (14) within the power amplifier (4) to change the dc supply voltage of the 'H' bridge driver (15). The drive signal mark-space ratio and repetition rate are obtained by the mark-space and repetition rate generator operating on the appropriate parameter values. The generator provides a unipolar drive signal to the 'H'

bridge driver (15) which then provides a bipolar voltage drive signal to the compressor coil(s) (10).

This bipolar voltage drive signal (Figure 2a) across the compressor coils may be represented by repetition rate 1/A, mark-space ratio B/A and amplitude switching between +V and -V. V is a voltage closely approximating the supply voltage to the 'H' bridge driver (15). Typically V might be around 12 volts with a repetition rate of several kilohertz and mark-space ratio varying from below one per cent to above 99 per cent.

If for the purposes of obtaining appropriate compressor fluid flow an actuator current of period x is required (Figure 2c) then over a time period of x the generator (3) will provide mark-space ratio values approximating two half sinusoids (Figure 2b), each over a period of x/2 and with uniform repetition rate. This drive signal combined with the switching action of the 'H' bridge driver (Figure 2-a) will create a complete bipolar near sinusoidal actuator coil current with a period of x as required. Typically x will be ten to a hundred times greater than A requiring a drive signal repetition rate equally much higher than 1/x.

The bipolar current in the compressor coil(s) enables the actuator to be displaced both positively and negatively with respect to its non-energised position. The actuator displacement results in the fluid pumping diaphragm(s) (12) being deflected to the required amount to provide the required flow rate of the fluid. The power amplifier (4) is supplied from mains power via a regulated or unregulated dc supply or from a dc battery.

It will be apparent to skilled practitioners of the art that for the invention except where indicated otherwise the command generator, mark-space and repetition rate generator, command processor, dc supply, power amplifier and amplitude controller can be implemented in any combination of analogue circuitry, digital circuitry or state machines including microprocessor systems.

It will also be apparent to skilled practitioners of the art that instead of diaphragms one can use other air displacement devices such as pistons, vanes, spirals, and that fluid flow out of as well as into the bladder system can be controlled.

Figure 3 shows a preferred embodiment of the invention where the characteristics of the compressor output fluid flow are known for varying loads, temperatures and pressures. In this case, a command signal representing the required fluid flow is created in the command generator (1) and applied to the command processor (2). The command processor (2) determines the repetition rate and mark-space ratio required from the mark-space and repetition rate generator (3) This results in a variable repetition rate and time varying mark-space ratio waveform representative of the current required in the compressor (6) coil or coils. The waveform is applied to the power amplifier (4) where it is controlled in amplitude by the amplitude controller (5), the amplitude being determined by the command processor (2). The output of the power amplifier (4) provides a voltage with the amplitude repetition rate and mark-space ratio controlled by the command processor. This voltage is applied to the compressor (6) coil or coils resulting in a known current,

therefore a known deflection of the compressor bellows and thus a known amount of fluid flow to the bladder system (7) by way of the fluid routing system (8). A dc power supply (9) is used.

Figure 4 shows the control of the fluid flow system as described in Figure 3 but applied to the control of the actuator position within the compressor by actuator position feedback. This control approach removes the effect of unknown variations within the electromagnetic drive means between drive signal and resulting actuator deflection.

A command signal representing the required fluid flow is created in the command generator (1) and added to the actuator position sensor (10) signal in the command processor (2) thus providing an error signal to ensure that the actuator position is achieved. This error signal from the command processor (2) determines the repetition rate and mark-space ratio required from the mark-space and repetition rate generator (3). This results in a variable repetition rate and time varying mark-space ratio waveform representative of the current required in the compressor (6) coil or coils. This waveform is applied to the power amplifier (4) where it is controlled in amplitude by the amplitude controller (5), the amplitude being determined by the command processor (2). The output of the power amplifier (4) provides a voltage with the amplitude repetition rate and mark-space ratio controlled by the command processor (2) and the actuator position sensor (10). This voltage is applied to the compressor (6) coil or coils resulting in a known deflection of the compressor bellows and thus a known amount of fluid flow to the

bladder system (7) by way of the fluid routing system (8). A dc power supply (9) may also be used.

Figure 5 shows flow control based on the principle that the actual fluid flow into a bladder is monitored to maintain the required fluid flow.

A command signal representing the required fluid flow is created in the command generator (1) and added to the information from the flow sensor (10) in the command processor (2) thus providing an error signal to correct any error in the required flow. This error signal from the command processor (2) determines the repetition rate and mark-space ratio required from the mark-space and repetition rate generator (3). This results in a variable repetition rate and time varying mark-space ratio waveform representative of the current required in the compressor (6) coil or coils. This waveform is applied to the power amplifier (4) where it is controlled in amplitude by the amplitude controller (5), the amplitude being determined by the command processor (2). The output of the power amplifier (4) provides a voltage with the amplitude repetition rate and mark-space ratio controlled by the command processor (2) and the flow sensor (10). This voltage is applied to the compressor (6) coil or coils resulting in a deflection of the compressor bellows and thus an amount of fluid flow to the bladder system (7) by way of the fluid routing system (8). Any errors in the flow being detected by the flow sensor (10) and being used as a correction signal into the command processor (2). A dc power supply (9) is used.

Alternatively, instead of flow being monitored, the actual pressure in the bladder may be monitored as shown in Figure 6.

Referring to Figure 6, a command signal representing the required bladder pressure is created in the command generator (1) and added to the information from the pressure sensor (10) in the command processor (2) thus providing an error signal that can be used to correct any error in the required bladder system (7) pressure. This error signal from the command processor (2) determines the repetition rate and mark-space ratio required from the mark-space and repetition rate generator (3). This results in a variable repetition rate and time varying mark-space ratio waveform representative of the current required in the compressor (6) coil or coils. This waveform is applied to the power amplifier (4) where it is controlled in amplitude by the amplitude controller (5), the amplitude being determined by the command processor (2). The output of the power amplifier (4) provides a voltage with the amplitude repetition rate and mark-space ratio controlled by the command processor (2) and the pressure sensor (10). This voltage is applied to the compressor (6) coil or coils resulting in a deflection of the compressor bellows and thus an amount of fluid flow to the bladder system (7) by way of the fluid routing system (9). Any errors in the pressure detected by the pressure sensor (10) is then used as a correction signal into the command processor (2). A dc power supply is used (9).

Claims:

1. A fluid flow control system for an electromagnetic pump comprising electromagnetic drive means within a compressor, the control system supplying a pulse width modulated drive signal to the electromagnetic drive means so as to supply a predetermined pump flow rate, the drive signal generated from a dc voltage supply.

2. A fluid flow control system as claimed in claim 1, wherein the pulse width modulated drive signal comprises a train of variable mark space ratio pulses with defined repetition rates and amplitude.

3. A fluid flow control system as claimed in claims 1 or 2, wherein the electromagnetic drive means includes stator(s) of magnetic material, excitation winding(s) for magnetically exciting the stator(s) and movable magnetic member connected to the actuator of the compressor.

4. A fluid flow control system as claimed in claim 3, wherein the electromagnetic drive means in combination with diaphragms provides a conversion of electrical energy to fluid flow.

5. A fluid flow control system as claimed in any preceding claim, wherein the pulse width modulated drive signal controls the instantaneous current within the excitation windings.

6. A fluid flow control system as claimed in claim 5, wherein the mark-space ratio of the drive signal defines with time an approximate half sinewave current waveform.

7. A fluid flow control system as claimed in claim 6, wherein the pulse width modulated drive signal is of substantially constant amplitude.

8. A fluid flow control system for an electromagnetic pump comprising electromagnetic drive means within a compressor, the control system supplying a pulse width modulated low voltage drive signal of substantially fixed amplitude to the electromagnetic drive means to control the amplitude and repetition rate of the current in the coils of the electromagnetic drive means to drive the actuator in order to generate a desired flow rate output from the compressor.

9. A fluid flow control system for electromagnetic pump comprising electromagnetic drive means within a compressor, the control system including a command generator creating a command signal corresponding to a predetermined desired fluid flow rate, sensor(s) to sense status of the system and provide feedback signal(s), the command signal and feedback signal(s) being processed by a command processor, the command processor providing a drive signal output, the drive signal defined by mark-space ratio, repetition rate and amplitude and controlling the voltage to be applied to the compressor windings.

10. A fluid flow control system as claimed in claim 9, wherein the sensor(s) provides feedback of instantaneous coil current.

11. A fluid flow control system as claimed in claim 9, wherein the sensor(s) provides feedback of actuator displacement.

12. A fluid flow control system as claimed in claim 9, wherein the sensor(s) provides feedback of bladder system pressure.

13. A fluid flow control system as claimed in claim 9, wherein the sensor(s) provides feedback of fluid flow into/out of bladder system.

14. A fluid flow control system substantially as hereinbefore described and with reference to the accompanying Figures 1 to 6.

Fig.1.

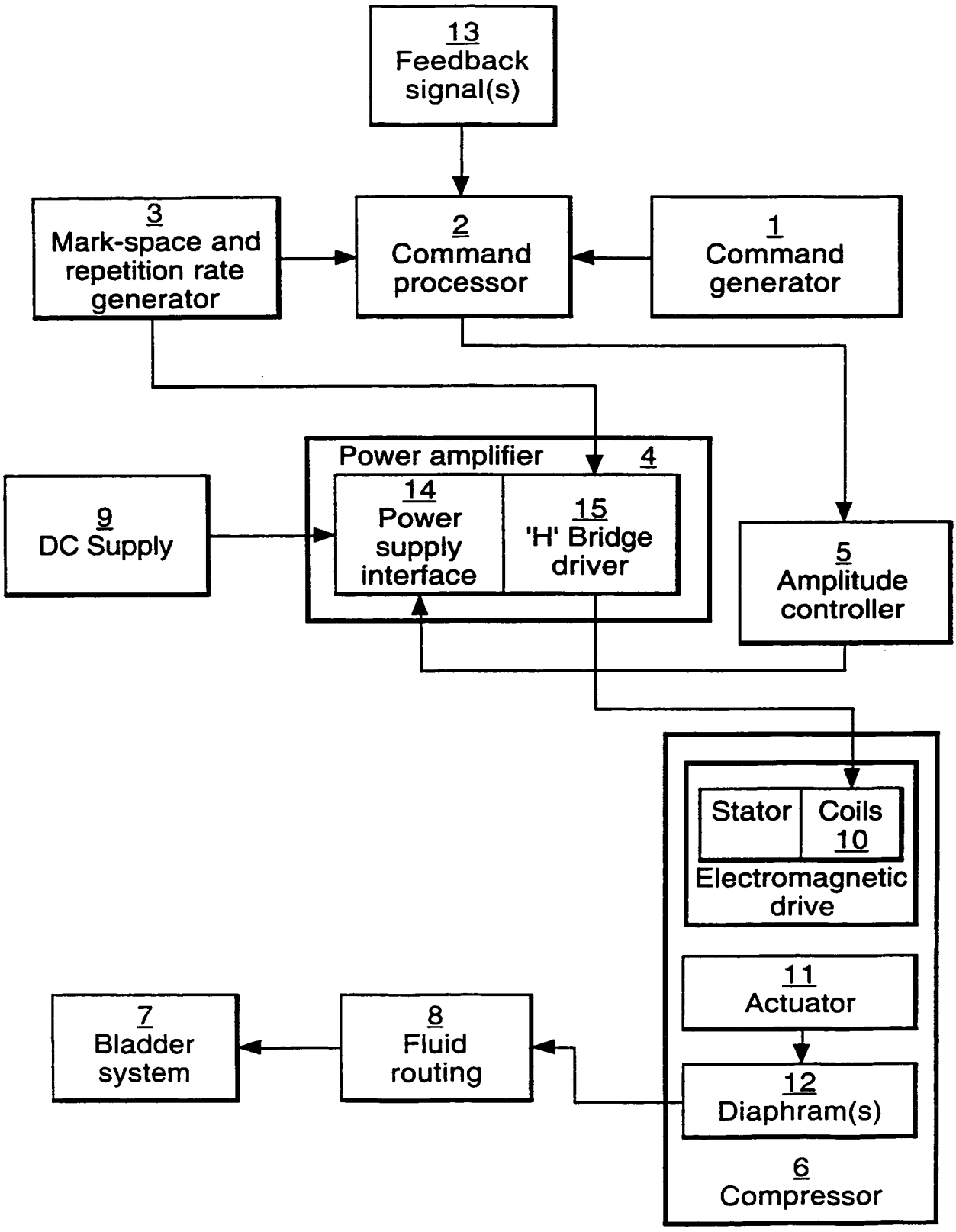

13
Feedback signal(s)
3
Mark-space and repetition rate generator
2
Command processor
1
Command generator
Power amplifier
4
14
Power supply interface
15
'H' Bridge driver
9
DC Supply
5
Amplitude controller
Stator
Coils
10
Electromagnetic drive
11
Actuator
12
Diaphram(s)
6
Compressor
7
Bladder system
8
Fluid routing

Fig.2a.

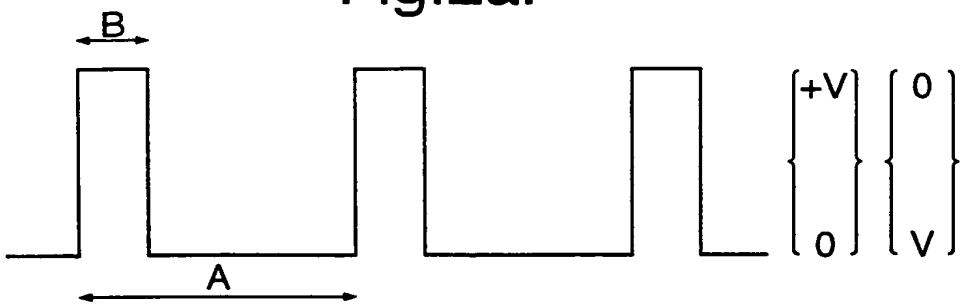


Fig.2b.

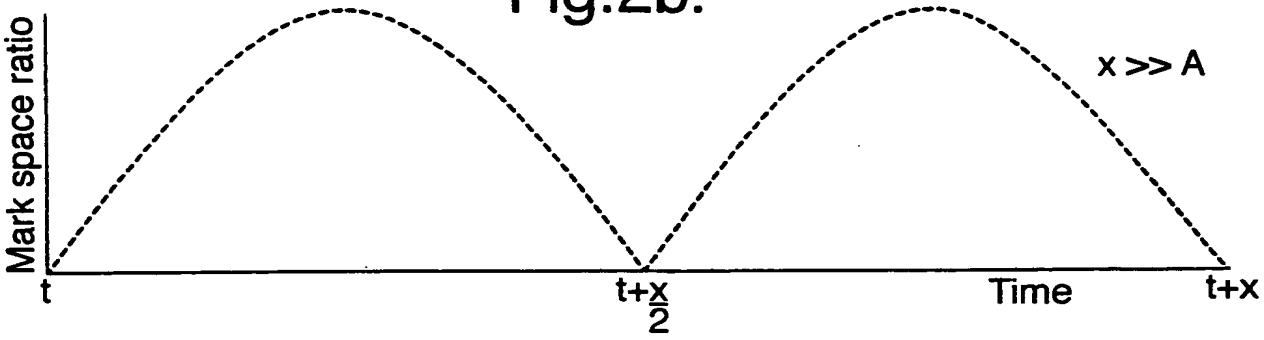


Fig.2c.

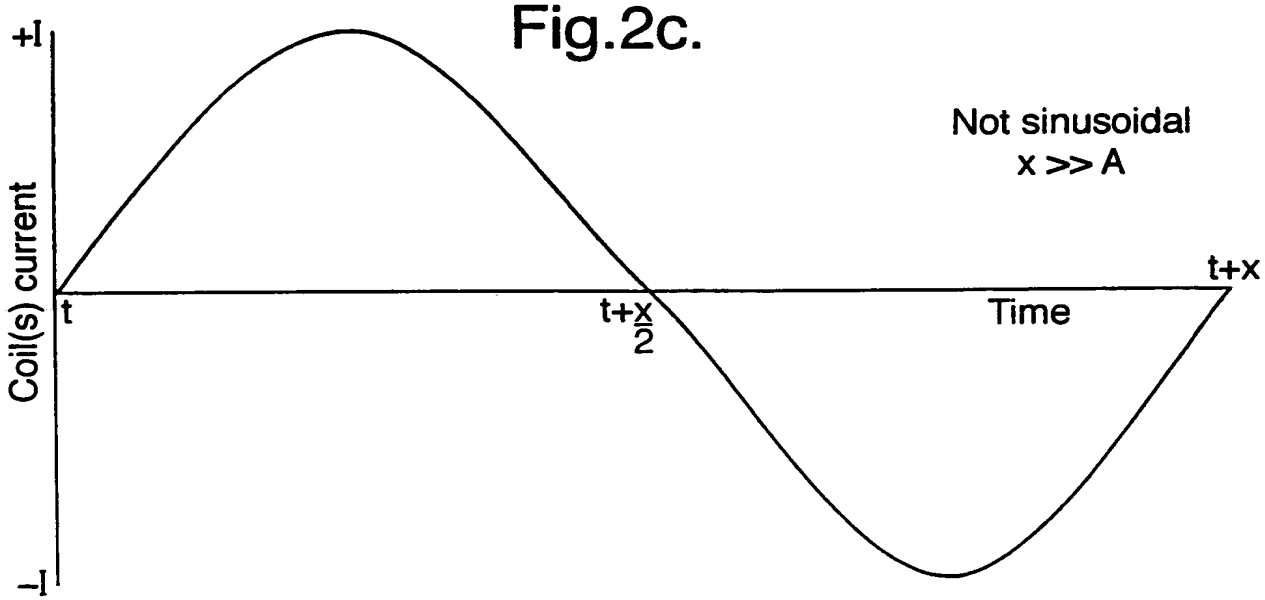


Fig.3.

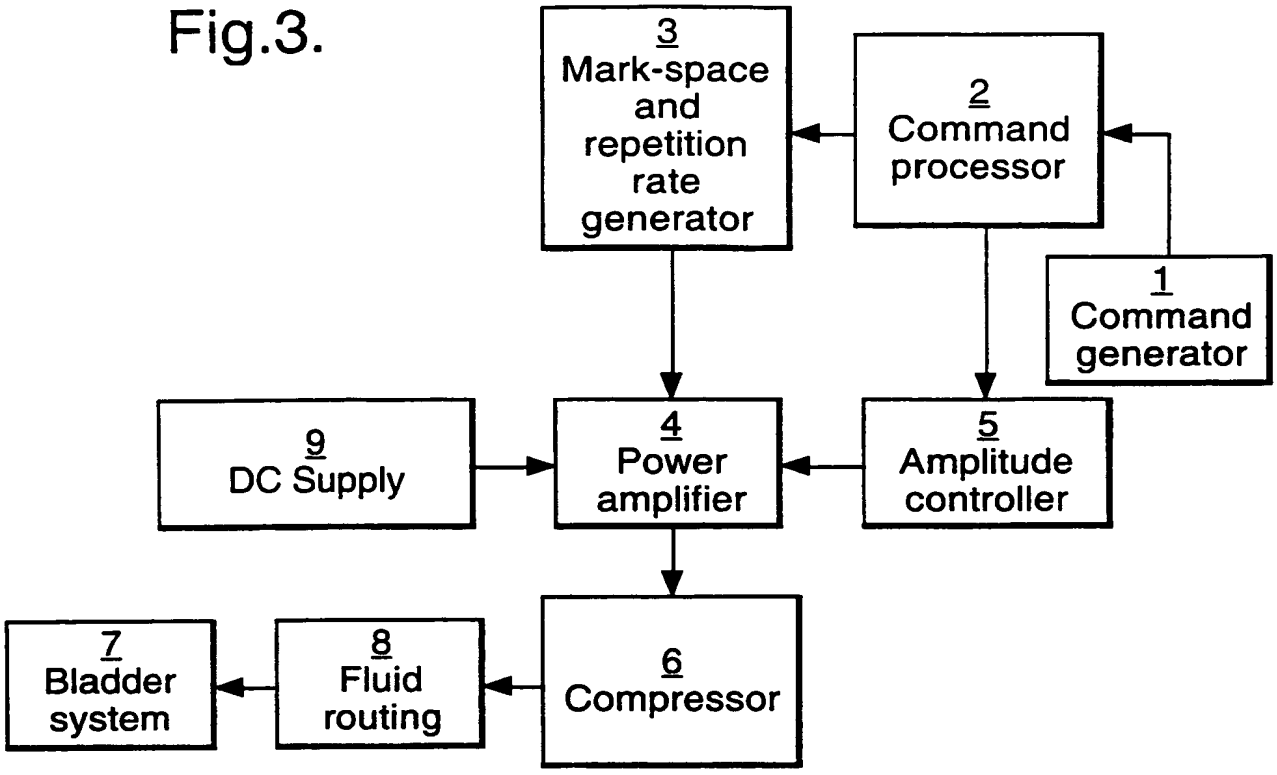

3
Mark-space and repetition rate generator
2
Command processor
1
Command generator
9
DC Supply
4
Power amplifier
5
Amplitude controller
7
Bladder system
8
Fluid routing
6
Compressor

Fig.4.

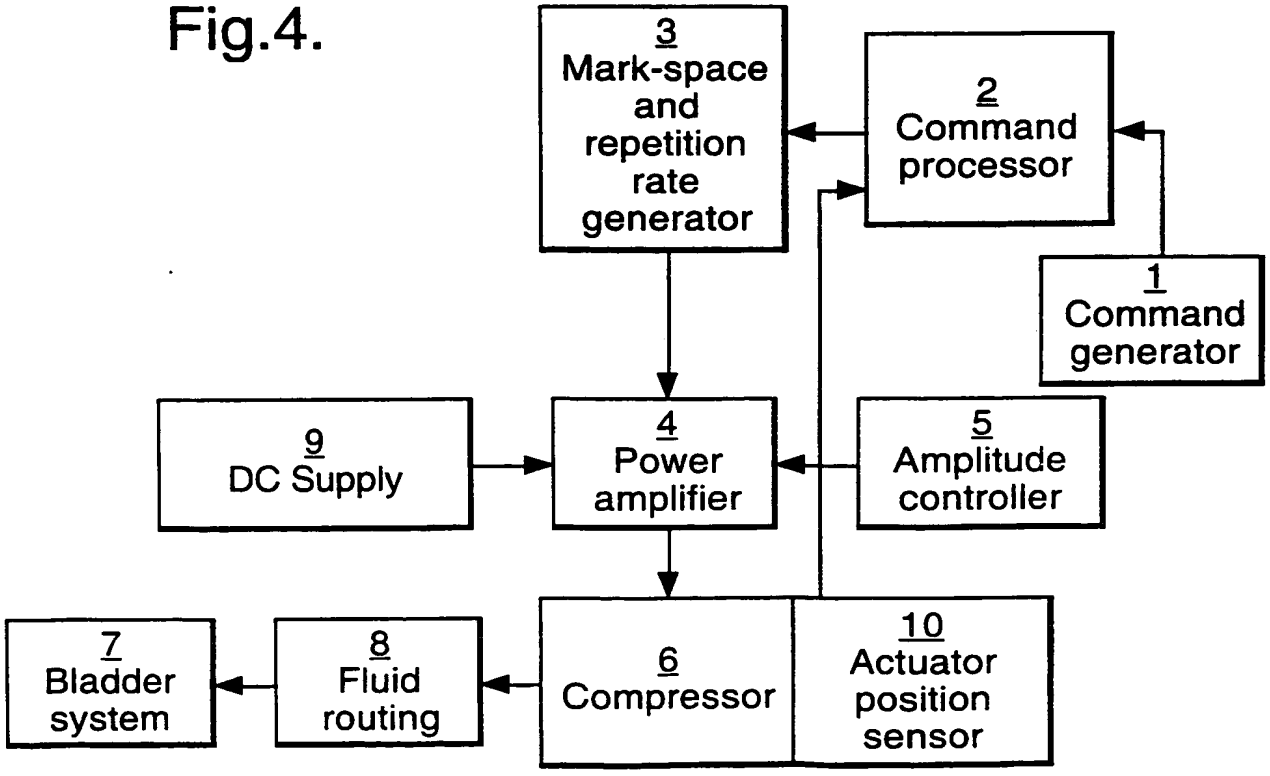

3
Mark-space and repetition rate generator
2
Command processor
1
Command generator
9
DC Supply
4
Power amplifier
5
Amplitude controller
7
Bladder system
8
Fluid routing
6
Compressor
10
Actuator position sensor

Fig.5.

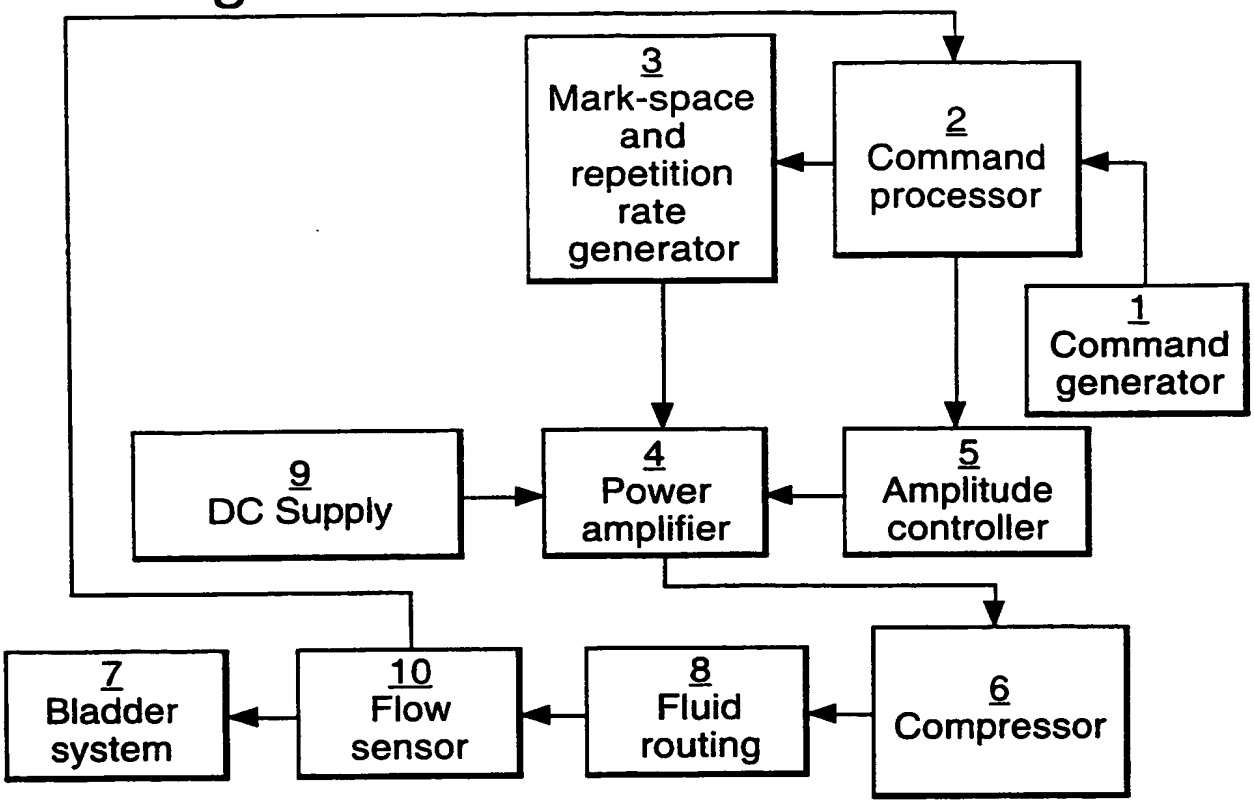
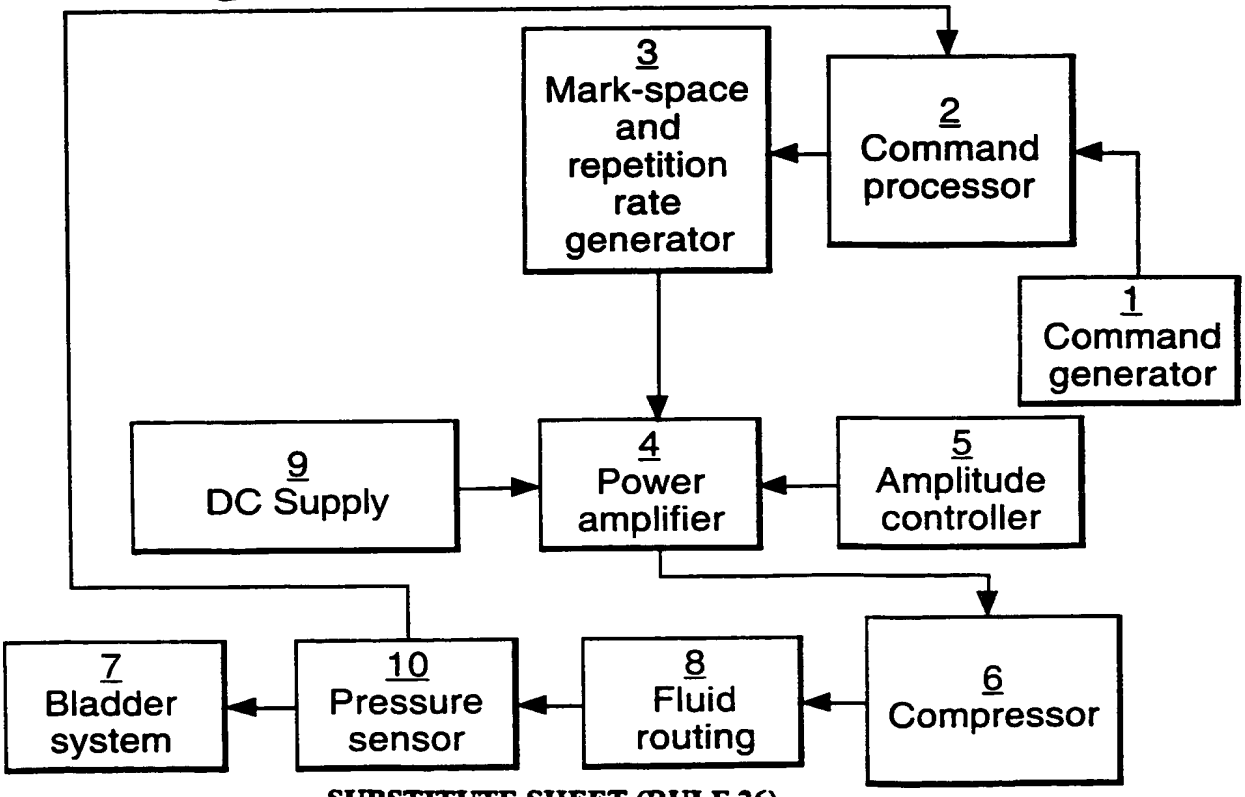

3
Mark-space and repetition rate generator
2
Command processor
1
Command generator
9
DC Supply
4
Power amplifier
5
Amplitude controller
7
Bladder system
10
Flow sensor
8
Fluid routing
6
Compressor

Fig.6.


3
Mark-space and repetition rate generator
2
Command processor
1
Command generator
9
DC Supply
4
Power amplifier
5
Amplitude controller
7
Bladder system
10
Pressure sensor
8
Fluid routing
6
Compressor

INTERNATIONAL SEARCH REPORT

Intern ıal Application No
PCT/GB 00/02931

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G05D7/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G05D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	US 5 671 730 A (OLLILA RAUNO) 30 September 1997 (1997-09-30) the whole document --- US 4 806 833 A (YOUNG GLEN C) 21 February 1989 (1989-02-21) column 4, paragraph 5 column 6, paragraph 3 -column 9, paragraph 3 figure 5 --- US 4 905 687 A (PONKALA JORMA) 6 March 1990 (1990-03-06) the whole document --- -/--	1-3,5,8, 14 4 6,7,9-13 1-3,9, 11,12,14 13 4-8,10 1,2,5, 8-10,12, 14 3,4,6,7, 11,13

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 October 2000	10/11/2000

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

Interr ıal Application No
PCT/GB 00/02931

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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